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Single-Shot Half NEX 256 × 256 Resolution EPI at 3 Tesla

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Purpose

The purpose of this study is to demonstrate the feasibility of half NEX single-shot high resolution (256 × 256) echo-planar imaging (EPI) with a FOV as low as 16 cm. Previous techniques used multi-shot interleaved strategies (1,2). With these techniques, a trade-off in temporal resolution and in phase stability is necessary. T₂* decay determines the point-response function. A further purpose is to compare half-NEX and whole-NEX point-response functions at the same resolution.

Methods

All studies were performed on a 3 T BIOSPEC 30/60 Bruker scanner with off-line reconstruction on an HP748 VME workstation. A Pentax 16-bit A/D converter was incorporated. Conversion was performed at a constant 1 M samples/sec and additional filtering was done digitally. A balanced torque three-axis local gradient coil with endcap bandpass birdcage rf coil was used for gradient-recalled EPI. TE=19.5 ms, TR=1 sec, thickness=5 mm, FOV=16 cm, BW=±88 KHZ, total readout time=235 ms. Half k-space reconstruction with 8 overscan lines at the beginning of the readout. A conventional bilateral finger movement motor cortex FMRI experiment was used to evaluate the sequence.

Results

Figure 1 shows three half-NEX anatomic images reconstructed in different ways from the same data set. Figure 2B was obtained with conventional 256 × 256 half-NEX reconstruction; Fig. 2A is a 256 × 128 image obtained by truncating the outer 64 points of k-space; and Fig. 2C is a 256 × 256 image obtained by artificially correcting each line in k-space for T₂* decay. It is apparent that the resolution of Fig. 2B is higher than 2A. The resolution is higher still in Fig. 2C, but the SNR is decreased. Figure 2A shows an expanded 256 × 256 anatomic image and Fig. 2B a functional correlation image. High resolution allows identification of vein and capillary effects.

Discussion and Conclusion

Improved resolution in FMRI without degradation of SNR is possible when physiological fluctuations dominate. At sufficiently high resolution, a cross-over occurs and thermal noise dominates. This cross-over appears to occur at about 128 × 128. For whole-NEX readout, the point response function is given by FWHM=4 TAD/(πT₂*) where TAD is the readout duration on one side of the full k-space readout. For half-NEX at the same resolution, FWHM is two times less. Fig. 3 shows a simulation of the point-response function for half and whole NEX. This factor of 2 is central to the work described here. It is estimated that the point-response function for half NEX at 3 T in human brain in the present study is about two pixels. Nevertheless, a noticeable benefit is observed

experimentally. Half-NEX EPI offers fundamental benefit in high resolution FMRI studies. An additional benefit is improved temporal resolution.

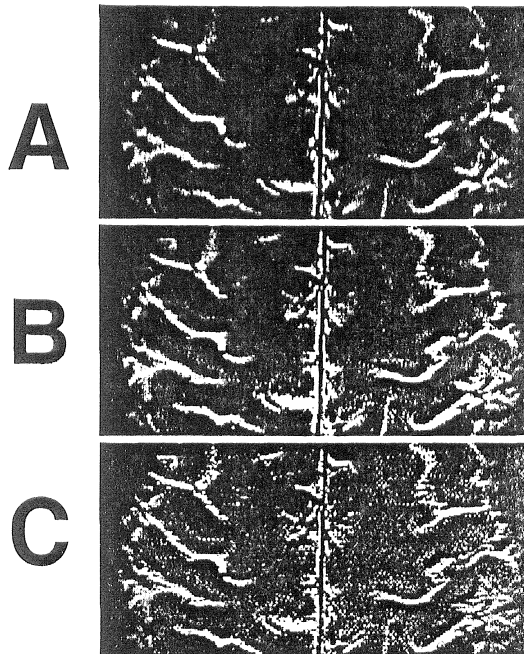


Figure 1. Anatomic image.

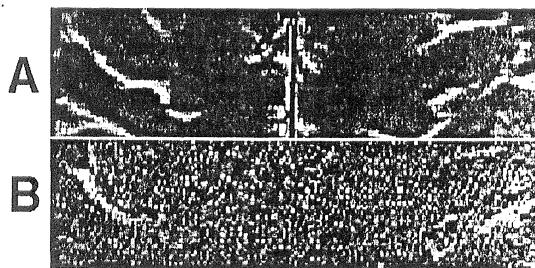


Figure 2. a, anatomic image; b, FMRI correlation image.

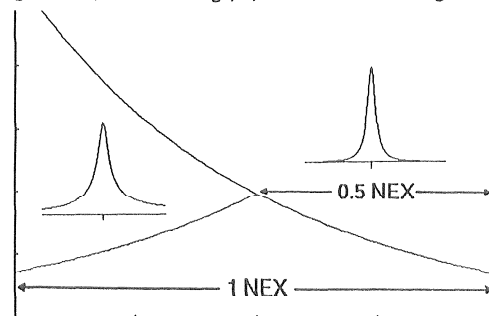


Figure 3. Simulation of the point-response function for half NEX.

References

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